# Some Effects of pH on Living Systems

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The phenomenon of acid rain is familiar to most students, but the devastating effects are abstract to beginning students. In this exercise we simulated the pH of an acid lake in an aquarium in the lab, and allowed students to measure some of the effects of high acidity on aquatic organisms.

Two aquaria (one at pH 5.0 and one at pH 7.5), each containing specimens of *Elodea* and goldfish (*Carassius auratus*), were maintained in the lab at the two pHs. A daily record of the pH was maintained, and students were encouraged to visually examine the aquaria throughout the semester. On the day of the experiment, photosynthetic rates of *Elodea* were estimated by measuring the release of oxygen bubbles from a cut stem for a period of 6 minutes. Light intensity was varied by making the measurements at different distances from the light source (20 cm, 40 cm, 60 cm, and 80 cm). Students were asked to plot photosynthetic rate as a function of light intensity and compare the curve from acid-exposed plants with that of neutral pH controls. The chlorophyll content of the *Elodea* plants from both aquaria was estimated by determining the area of five leaves, crushing the leaves in 80% acetone to release the chlorophyll and spectrophotometrically measuring the absorbance of the extract at $OD_{652}$ (Witham et al., 1986):

$$mg\ total\ chlorophyll/mm^2\ tissue = \left(\frac{OD_{652}\ x\ 1000}{34.5}\right) x \left(\frac{V}{1000\ x\ A}\right)$$

where $OD$ = optical density at 652 nm, $V$ = volume of chlorophyll extract, and $A$ = total area of leaves in $mm^2$.

The respiratory rates of goldfish taken from both pH 5.0 and pH 7.5 were estimated by counting the number of operculum movements per unit of time. The ability to maintain respiratory rates at decreasing temperatures was compared by making measurements at room temperature (22°C), 15°C, 10°C, and 5°C. Students compared the rate-temperature plots for fish from pH 5.0 and pH 7.5.

Data indicate a downward shift in the rate-intensity curve for *Elodea* plants from pH 5.0 relative to those from pH 7.5, with no significant change in chlorophyll content. Goldfish from pH 5.0 exhibited an upward shift in the rate-temperature curve relative to those from pH 7.5. Students were required to write a report, including current literature citations, discussing their results with reference to acid rain and the effects that high acidity has on aquatic organisms and ecosystems.

Witham, F. H., D. F. Blaydes, R. M. Devlin. 1986. Exercises in plant physiology. Prindle, Wever, Schmidt, Boston, Massachusetts.